**EGM722 Marine Project: How-To Guide**



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Link to the repository: <https://github.com/katiek23/MarineProjectEGM722>

**Introduction**

As a Scientific Officer within the Department of Agriculture, Environment and Rural Affairs (DAERA), I work within the Marine Monitoring and Assessment team in the Marine and Fisheries Division. I noticed that the data we collect very often remain in Excel spreadsheets and .csv file formats, ready for collating into global marine databases. However, this format is not the most user-friendly, especially for members of the public who may be interested in visualising this data. This guide illustrates how Python coding can be used to create user-friendly interactive maps of Ireland and Northern Ireland’s marine data.

A marine protected area is a region that has been specifically designated for the efficient preservation and conservation of marine species, ecosystems and cultural resources. MPAs are now also designated to encourage the sustainable use of natural resources and the protection of ecosystem services, not solely for biological conservation purposes (Schéré *et al*. 2021).

There is a need for tools to aid in the design and management of MPAs as the UK Marine Bill and comparable pledges in other countries are supporting the establishment of a network of marine protected areas (Glenn *et al.* 2010). Due to insufficient site monitoring, information on how well these protected areas perform in achieving their conservation goals is sparse. Fishing, for example, tends to largely impact biodiversity, from population sizes to age structure and food webs. Shockingly, 94% of MPA still allow fishing within their boundaries (Costello and Ballantine, 2015).

This project aims to explore the benthic areas around Ireland and to plot the presence of fishing activity and fish sightings in relation to marine protected areas and seagrass beds around the Irish and North Seas, using Python. Python code was developed using Cartopy and Matplotlib packages to create a marine map for the visualisation of Ireland’s marine data. In recent years, Python and R studio have proven themselves as useful tools for presenting oceanographic and ecological data (Hope, 2017; Alyuruk, 2019; Dodino *et al*. 2021). Further, comparison to fishing activity can help determine whether an overlap in their distribution exists and whether this could have negative consequences for population health. Providing visual aids in the form of interactive maps can aid in public understanding and access to data.

**Set-Up and Installation**

The Python code, relevant data files, dependencies for installation and repository can be accessed here:

[katiek23 repository] (<https://github.com/katiek23/MarineProjectEGM722>).

The following code has been designed to be run in an Integrated Development Environment (IDE) such as PyCharm. It is therefore suggested that PyCharm Community Edition is used to run the code as it has not been tested across other environments. The dependencies and main packages for installation can also be viewed in the **marine\_environment.yml file** [https://github.com/katiek23/MarineProjectEGM722/blob/main/marine\_environment.yml] and below in Table 1.

Table 1: Illustrating the main Python packages required for installation and their uses

|  |  |
| --- | --- |
| **Package** | **Function** |
| Cartopy | Produce maps with geospatial data |
| Matplotlib | Creates plot visualisations |

**Recommended step-by-step guide for running code**

1. Fork the repository [katiek23] (<https://github.com/katiek23/MarineProjectEGM722>) to create a copy on your GitHub Account.
2. Clone the copy to GitHub Desktop
3. Using Anaconda Navigator, create a new environment with the relevant title (eg. marine), using the marine\_environment.yml file provided in the GitHub Repository.
4. Follow through to the new environment (marine) and install PyCharm (community edition).
5. In PyCharm, open the Python script, Marine\_map\_creation.py. Once open, click where it says, “Python 3.9” in the bottom right of the corner, click ‘Add interpreter’, then ‘Conda environment’, and then select ‘marine’, and ensure the new conda environment is navigated to.
6. Then click ‘Add configuration and add the path to the script you are trying to run, and ensure “Python interpreter” is set to the correct environment
7. You should now be able to run the Python script.

All project data required for this code is included in the ‘Project Data’ folder within the MarineProjectEGM722 repository. Thank you to the Ireland Marine Atlas, Cefas and OpenDataNI who kindly present this data as freely available to the public. Their websites can be found at [Ireland Marine Atlas] (<https://atlas.marine.ie/#?c=53.9108:-15.8862:6>), [CEFAS] (<https://data.cefas.co.uk/view/3277> ) and [OpenDataNI] (<https://www.data.gov.uk/>). Data files were obtained in shapefile (.shp) or comma-separated variables (.csv) file format for easier integration into Python code.

Users should have at least 350MB of space on their drive to allow all files to be downloaded and utilised.

**Methodology**

**Using Cartopy and matplotlib python packages for map creation**

The marine\_map\_creation.py file begins by importing all the relevant Python packages required for map creation. Next, matplotlib is used to generate handles to create a map legend and create a scale bar relevant to the map projection. All data is loaded onto PyCharm into a geodatabase format using the GeoPandas package, which makes it easier to work with rows and columns of data, similar to an attribute table within ArcGIS Pro.

The next block of code works for building our map figure (Korstanje, 2022). Matplotlib is a trusted package, proven appropriate for marine scientists preparing figures for papers and executing data visualisation on maps (Hope, 2017). It was important to set our coordinate reference system (CRS) to coincide with the location of our data. CRS was set to UTM Zone 29, within WGS 84, covering between 12°W and 6°W and the Northern hemisphere between the equator and 84°N onshore and offshore (EPSG.IO, 2020). Further, the extent of our map was set to ensure our map contains the relevant study areas. Features were created for each of the shapefiles and allocated face colours, linewidths and CRS using the ShapelyFeature class from the cartopy.feature package to add the shapefiles to our map.

However, for the fish nursery grounds dataset, a function was required to give each unique fish species a corresponding colour code in the legend. Firstly, a simple list function was created to find out the number of unique fish species names which was then used to work out how many individual colours were required. Finally, this feature was added to the map.

Next, the generate\_handles function from matplotlib was used to create a list of handles we wanted to include in the legend. Finally, map gridlines and titles were added to complete the figure. The map .png file can be exported to your repository by using the myFig.savefig function.

**Expected Results**

Once the code has run, a map of Northern Ireland and the surrounding Irish Sea with all the marine data elements will be saved as a PNG file in the project folder. I created a preliminary map using the data shapefiles on ArcGIS Pro beforehand to gauge an idea of what the figure would look like (Figure 1; Figure 2).

A picture containing calendar

Description automatically generated

Figure 1: Marine map of Northern Ireland and the Irish Sea, indicating marine protected areas, inland fisheries, seagrass habitat and fish nursery grounds.

A picture containing graphical user interface

Description automatically generatedFigure 2: Marine map of Northern Ireland and its surrounding coast, indicating marine protected areas, seagrass habitat and fish nursery grounds.

Once the code has run, the following output map should appear and save on your repository drive (Figure 3).

Diagram

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Figure 3: Python code output map of the British Isles and the surrounding Irish / North Sea. Seagrass, marine protected areas, areas of inshore fishing activity and fish nursery grounds are shown.

**Troubleshooting**

This section describes potential errors that may occur whilst running the code and suggests some quick fixes to help overcome these problems. If an error occurs that is not listed below, please leave a comment on the Git Repository.

* **Cartopy installation problems:** When initially trying to run the code, line 5 may appear greyed out. An error message may appear stating that the cartopy package was unused within your code. I found that this was a common error online so to overcome this, PIP needs to be updated to the most current version by entering the following command into your terminal [pip install –upgrade pip] <https://www.jetbrains.com/help/pycharm/package-installation-issues.html>
* **Index error:**  This error arises when an item in a list attempts to be accessed at an out-of-bounds index. Python lists have a range of [0, n-1], where n is the total number of elements in the list. An [IndexError: list index out of range] error is raised when an attempt is made to access an item at an index outside of this range. To overcome this error on line 67, I had to ensure that all commas were present.

[https://rollbar.com/blog/python-indexerror/#](https://rollbar.com/blog/python-indexerror/)

* **Map extent appears too zoomed out:** If the output figure from running the code appears minuscule with shapefiles appearing as dots, this means that the extent of the map frame is incorrect on line 61. I found that trial and error worked best in replacing the x and y values until the output figure included Ireland and the British Isles at the correct location. Despite methodologies suggesting figures between 1000- 5000, a value of 10 worked best for the Irish CRS (EPSG: 2157).

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